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Do men and women differ in their use of tables and graphs in academic publications?

James Hartley · Guillaume Cabanac

Abstract In psychological research there is huge literature on differences between the sexes. Typically it used to be thought that women were more verbally and men more spatially oriented. These differences now seem to be waning. In this article we present three studies on sex differences in the use of tables and graphs in academic articles. These studies are based on data mining from approximately 2,000 articles published in over 200 peer-reviewed journals in the sciences and social sciences. In Study 1 we found that, in the sciences, men used 26 % more graphs and figures than women, but that there were no significant differences between them in their use of tables. In Study 2 we found no significant differences between men and women in their use of graphs and figures or tables in social science articles. In Study 3 we found no significant differences between men and women in their use of what we termed 'data' and 'text' tables in social science articles. It is possible that these findings indicate that academic writing is now becoming a genre that is equally undertaken by men and women.

Keywords Academic writing · Textual design · Tables · Graphs · Gender studies

> *When reading journal articles I just skip over the tables: there's too many numbers.*
> (Female university student, Keele, 2005)

> *He basically said that if I repeated what was said in the lectures and added in a few graphs I would get a good degree.*
> (Female university student, Keele, 2013)

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Introduction

Do men and women authors differ in their use of tables and graphs in their research articles? In the 1960s it was generally thought in the West that men were more spatially and mathematically oriented than women and that women were more verbal (Maccoby and Jacklin 1974). This division was reflected in the major intelligence tests of the time that typically came in two halves—a verbal and a spatial one (e.g., see Heim 1970). And, in addition, males performed better than females on spatial rotation tasks (Maeda and Yoon 2013). Further, it was thought (and often still is) that girls were better at writing than boys (Peterson and Parr 2012).

More recently, however, these divisions have been less subject to debate than they were. It is now generally thought that men and women are equally adept at both spatial and verbal tasks (e.g., see Hyde et al. 2008), with perhaps men having wider tails in the distributions of their scores (Robinson and Lubienski 2011). Similarly, some researchers argue that the differences between boys and girls in terms of their academic writing have also lessened (Hartley 2008). Indeed, popular thinking in education in the UK has generally switched from 'helping the girls' in the 1960's to currently 'helping the boys' to achieve their potential (Strand et al. 2006).

However, the matter *is* still debated. There are still gender gaps in certain disciplines, with many more men than women studying subjects like mathematics, and engineering, and many more women than men studying subjects like psychology and biology (Good et al. 2012; Hartley 2006). And there are still the remnants of the earlier differences.[1] Wai et al. (2012) recently examined differences between men and women university students at the top end of the mathematical and verbal distributions of test scores (where one might expect to find potential academics). Here the men still scored higher than the women on tests of mathematical ability (although not as highly as in the past), but there were now fewer differences between them on tests of verbal ability. Similarly, the findings are mixed in terms of students' academic writing. Here a number of studies have looked to see whether or not men write differently from women students in a number of different situations [e.g., using e-mails, writing examination articles, and in academia: see (Hartley 2008, pp. 161–162)].

Hartley (2008, pp. 163–164) reported the results obtained from comparing the writing styles of men and women in six genres—academic book reviews; academic articles; student essays; tabloid newspapers; novels; and magazine fiction. He found that the writers (of either sex) tailored their writing to the style required by the genre: academic texts were hard and difficult to read, students essays were a bit clearer; newspaper articles a bit more clear; and novels and magazine fiction easier to read. But this pattern of performance was the same for the men and the women: there were no significant differences between their writing styles, whereas there were significant differences between the results found for each genre. Hartley (2008) thus argued that men and women did not differ in their writing styles—they just adapted them to fit the situation. Perhaps the same might be said of men and women using tables, figures and graphs, and thus we would not predict differences between them in using these academic tools?

Nearly all of the studies cited above have, of course, involved English speaking participants. Studies carried out in other cultures may reveal similar or more varied findings. Isiksal and Cakiroghi (2008), for example, found a similar decline over time in the

[1] Holpuch (2013) reports a recent news item stressing the sexist mindset of some people about women in Science: "to the apparent shock of some Facebook users, girls can be quite good at science."

differences between boys and girls in mathematics in Turkey, but Park (2005) reported that male Korean students achieved significantly higher mathematical scores than did their female counterparts.

Previous research on tables and graphs in academic journals

There are several famous books and articles on the different functions of tables and graphs in academic text (e.g., Carter 1947; e.g., Cleveland 1994; e.g., Gelman et al. 2002; e.g., Smith et al. 2002; e.g., Speier 2006; e.g., Tufte 1983). However, we have been unable to find any articles on the use of graphs and tables by men and women. Hegarty and Walton (2012) did, however, include these variables in their study of factors in Psychology journals that affected citation rates and impact factors, but no important sex differences were found with respect to tables and graphs.

In this article we ask whether men and women academic writers differ in their use of tables and figures in academic articles. In Study 1 we ask this question with respect to science journals. In Study 2 we ask the same question for the social science. In Study 3 we ask if there are differences between men and women in the use of what we might call ‘text’ tables (containing mainly verbal summaries, etc.) and ‘data’ tables (containing mainly data). Following Hanson et al.’s (2011) recommendations, we release the data retrieved and used in this study as an Electronic Supplementary Material.

Arguing from the standpoint that men might be more mathematically and spatially oriented, and women verbally so, we derived the following hypotheses:

H1 Men will have more proportionally graphs and figures in their scientific articles than women.

H2 Women will have proportionally more tables in their scientific articles than men.

H3 Men will have proportionally more graphs and figures in their social science articles than women.

H4 Women will have proportionally more tables in their social science articles than men.

H5 Men will have a higher ratio of ‘data’ tables to ‘text’ tables than women in their social science articles.

H6 Women will have a higher ratio of ‘text’ tables to ‘data’ tables than men in their social science articles.

Study 1. Science articles

Do male and female researchers use the same proportions of tables and graphs in their scientific articles?

Hypotheses

H1 Men will have proportionally more graphs and figures than women in science journals.

H2 Women will have proportionally more tables than men in science journals.

Procedure

To test these hypotheses we needed to:

1. Select acknowledged peer-reviewed journals from a wide range of scientific domains (for generalization purposes).
2. Consider the journals' contents published during a fixed time window (in order to avoid any bias arising from developments in information technology). As it is now easier to produce graphs and figures than it was in the 1980s, we needed to set a recent time window in order to report topical findings.
3. Select all single-authored research articles included in these journals.
4. Retrieve the full-text version of these articles.
5. Count the number of pages (P), the number of tables (T), and the number of figures (F) in each article.
6. Filter the articles so that we retain those with $F + T > 0$ (i.e., at least one figure or one table).
7. Normalise F and T to avoid the confounding variables that different articles have different lengths, and longer articles are more likely to contain more tables and figures than shorter articles. To avoid this we need to normalize T and F by P for an average 10-page long article. We obtain $T' = 10 \cdot T/P$ and $F' = 10 \cdot F/P$.
8. Annotate each article as "*M*" or "*W*" according to the author's gender, as inferred from the author's: (a) first name, or (b) online picture, or (c) by deducing it from his/her online website (looking for pronouns "his"/"her").
9. Group the articles by gender and define four samples:
   (a) T'_M and T'_W show the use of tables.
   (b) F'_M and F'_W show the use of figures.
10. Compare T'_M and T'_W to check if the difference in the use of tables among men and women is statistically significant. Visual inspection is performed with notched boxplots (McGill et al. 1978). A notch is drawn in each side of the boxes. If the notches of two plots do not overlap this is "strong evidence" that the two medians differ (Chambers et al. 1983, p. 62). Then, we further the visual analysis by running the non-parametric Mann−Whitney U test on the two samples (two tailed). The null hypothesis H_0 assumes no difference between the ranks of the two samples.
11. Repeat this exercise for the case of figures: compare F'_M and F'_W.

Data

In this section we review each point of the Procedure section above to indicate how we implemented and operationalized our research design.

- Point 1. We considered the 8,336 science journals listed in the Thomson-Reuters *Journal Citation Reports* (*JCR*),[2] Science edition 2011. We then selected the 752 science journals published by Wiley-Blackwell because the full-text of these articles were available online in valid HTML format (suitable for data extraction). We then tagged these journals with their *JCR* categories from the 176 categories spanning the whole range of domains in the Sciences (e.g., Agronomy, Logic, Pathology). For each

[2] http://webofknowledge.com/JCR/JCR.

category, we retained the journal with highest number of published articles per year. If this journal had already been selected we picked the following one, if it was available. In the end, we considered 148 distinct journals: one per category (when available). The rationale behind this choice was (a) to consider journals from all scientific domains, while (b) maximizing the number of articles considered, and (c) having various levels of impact factors to foster journal diversity.

- Points 2–4. We studied a total of 3,576 single-authored articles published in 2011, for which we downloaded the full-text in HTML.
- Points 5–6. We extracted *P* from article metadata. Computing *T* and *F* was achieved by extracting and counting specific HTML tags. A total of 1,682 single-authored articles with at least one figure or were further considered.
- Points 7–10. We manually identified the gender of 1,403 authors (83 %). We thus ended up with 1,143 articles by men and 260 articles by women (23 %). Significance tests were computed with the SOFA statistical package.

Results

H1 Men will use proportionally more figures and graphs than women in scientific articles.

In a typical 10-page science article there were a mean of 4.85 figures ($Mdn = 4.00$), as showed in Fig. 1. When grouping articles according to their author's gender, we found that men ($M = 5.04$) used 26 % more figures and graphs than women ($M = 4.00$). Moreover, this difference is statistically significant (men $Mdn = 4.17$ vs women $Mdn = 3.33$, $U = 125{,}863.5$, $p < 0.001$). As a result, our data positively support Hypothesis 1.

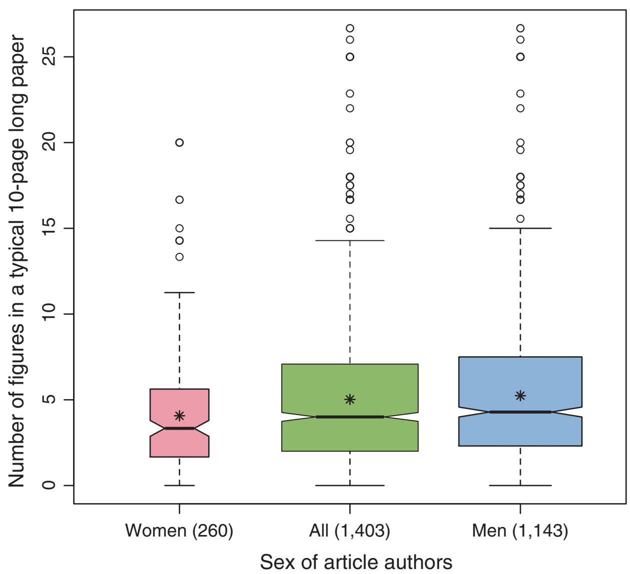

Fig. 1 Notched boxplots showing the distribution of the number of figures used in a typical 10-page science article (F'). Differences among men and women are statistically significant ($p < 0.001$)

H2 Women will use proportionally more tables than men in scientific articles.

In a typical 10-page science article there were a mean of 1.83 tables ($Mdn = 1.11$), as showed in Fig. 2. When grouping articles according to their author's gender, we found that women ($M = 1.99$) used 11 % more tables than men ($M = 1.79$). However, this difference is not statistically significant (men $Mdn = 1.11$ vs women $Mdn = 1.36$, $U = 139{,}086.0$, $p = 0.102$). As a result, our data do not support Hypothesis 2.

Study 2. Social science articles

Do men and women researchers use the same proportions of tables and figures in their social science articles?

Hypotheses

According to our Introduction above we hypothesized:

H3 Men will use proportionally more figures and graphs than women in social science articles.

H4 Women will use proportionally more tables than men in social science articles.

Data

We replicated the procedure used for Study 1, only this time we analysed the presence of tables and graphs in social science journals. Thus, in more detail:

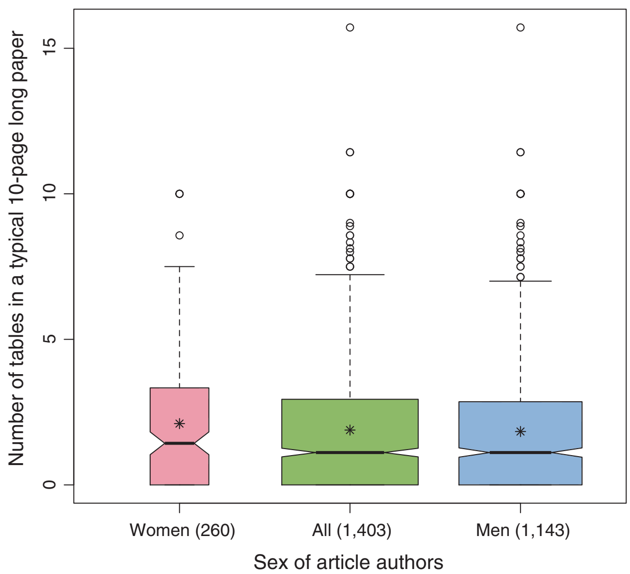

Fig. 2 Notched boxplots showing the distribution of the number of tables used in a typical 10-page science article (T'). Differences among men and women are not statistically significant ($p = 0.102$)

- Point 1. We considered the 2,966 journals listed in the *JCR* Social Sciences edition 2011. We selected 384 journals published by Wiley-Blackwell in HTML format. We tagged these journals with their *JCR categories*, leading to 56 such categories spanning the whole range of domains in the social sciences (e.g., Anthropology, Linguistics, Sociology). For each category we retained the journal with the highest number of published articles per year if it had not already been selected, whereupon we picked the following journal. We ended up with 54 distinct journals, one per *JCR* category (when available).
- Points 2–4. We studied a total of 2,091 single-authored articles published in 2011, for which we downloaded the full-text in HTML.
- Points 5–6. We extracted P from the article metadata. Computing T and F was achieved by extracting and counting specific HTML tags. A total of 662 single-authored articles with at least one figure or one table were further considered.
- Points 7–10. We identified the gender of 655 authors (99 %). We thus ended up with 441 articles by men and 214 by women. Significance tests were computed with SOFA statistics.

Results

H3 Men will use more figures than women in social science journal articles.

Analysis of the data showed that a typical 10-page long social science article contained a mean of 1.33 figures ($Mdn = 0.714$), as showed in Fig. 3. When we grouped the articles according to gender, we found that men ($M = 1.32$) used 3 % less figures than women ($M = 1.35$). However, this difference is not statistically significant (men $Mdn = 0.71$ vs women $Mdn = 0.77$, $U = 46{,}793.5$, $p = 0.861$). So, our data do not support Hypothesis 3 for social science journals.

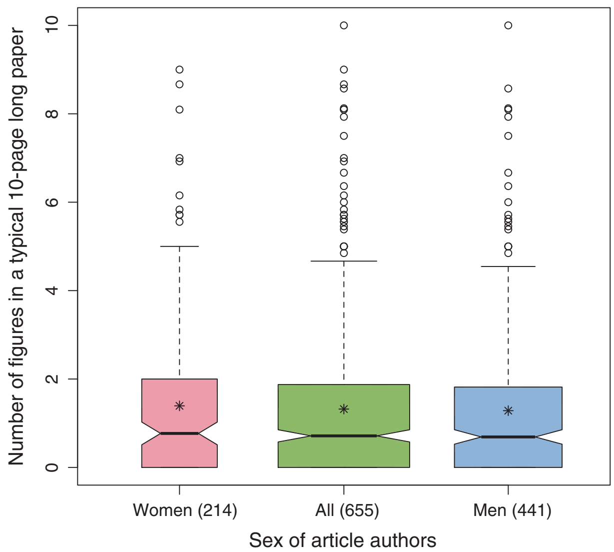

Fig. 3 Notched boxplots showing the distribution of the number of figures used in a typical 10-page social science article (F'). Differences among men and women are not statistically significant ($p = 0.861$)

H4 Women will use more tables than men in social science journal articles.

In a typical 10-page long social science article there were on average 1.94 tables ($Mdn = 1.48$), as showed in Fig. 4. When grouping articles according to their authors' gender, we found that women ($M = 1.93$) used 1% less tables than men ($M = 1.95$) and that this difference was clearly not significant (men $Mdn = 1.50$ vs women $Mdn = 1.43$, $U = 46{,}566.5$, $p = 0.784$). As a result, our data do not support Hypothesis 4.

Study 3. Social science articles

Do men use more 'data' than 'text' tables in their articles in the social sciences, and women more 'text' tables?

There are different sorts of tables, of course, as well as different sorts of figures. In the light of our introductory remarks we wished to see whether or not women would use more 'verbal' or 'text' tables than men, and whether or not men would use more numerical or 'data' tables than women. We hypothesized that women would use proportionately more 'text' tables than men, and that men would use proportionally more 'data' tables than women.

Hypotheses

H5 Men will have a higher ratio of 'data' tables to 'text' tables than women in their social science articles.

H6 Women will have a higher ratio of 'text' tables to 'data' tables than men in their social science articles.

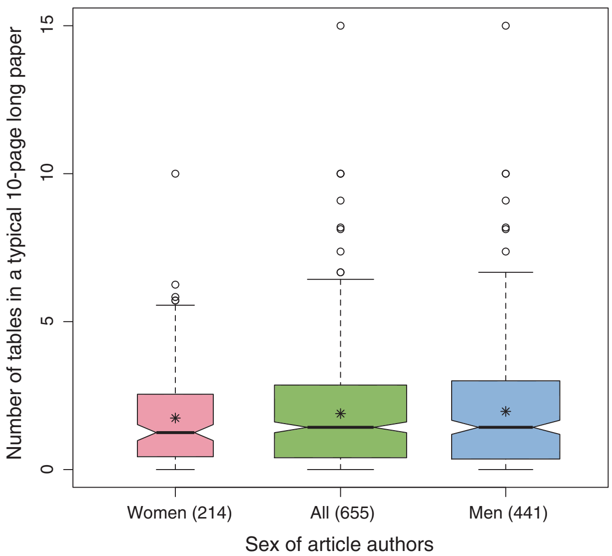

Fig. 4 Notched boxplots showing the distribution of the number of tables used in a typical 10-page social science article (T'). Differences among men and women are not statistically significant ($p = 0.784$)

Method

In this study we had to count and classify the tables produced by men and women by hand. Our previous electronic analyses of journals only counted the number of tables and figures by these designations in the text: they did not report on the kinds of tables (or figures) used. Accordingly what we did was:

1. Select journals that we had to hand (in the social sciences) or that we could read online.
2. Select those articles written by men or by women (in singles or multiples) and discount any articles written by members of both sexes.
3. Examine whether or not there were tables in each of these articles and record a single 'Yes' appropriately for each article if it contained text or data tables, or both.

We then totaled the numbers of articles using text and data tables for male and female authors overall. Table 1 gives the results. It can be clearly seen that although a greater proportion of female authors than men use text tables there are no significant differences between them. As a result, hypotheses H5 and H6 are not supported.

General discussion

The main findings from these three studies suggest that there are few, if any, differences between the use of tables and graphs by men and women, except in the Sciences. Study 1, in fact, was the only one that provided support for the hypothesis (H1) that men would use more figures and graphs than women in scientific articles. We wonder, therefore, if this is just typical of the disciplines and that graphs are more common in the sciences or that the use of tables in social sciences might be more effective if they were to be turned into graphs more often (Gelman et al. 2002).

Table 1 Number of authors using text and data tables in 10 social science journals published in 2012

Journal	Vol	Parts	Number of tables			
			Women		Men	
			Text	Data	Text	Data
British Journal of Educational Psychology	82	4	1	6	0	2
British Journal of Educational Technology	43	8	4	7	4	8
Human Factors	54	6	2	3	9	18
Innovations in Educational and Teaching International	49	4	10	8	0	3
Journal of Applied Psychology	25	6	5	8	1	3
Journal of Educational Psychology	104	4	5	19	5	8
Journal of Personality and Social Psychology	102	6	1	7	2	14
Review of Educational Research	8	4	3	2	2	1
Studies in Higher Education	37	8	8	4	4	12
Teaching of Psychology	39	4	2	8	3	5
Totals	–	–	41	72	30	74

Vol refers to the considered volume number

Nonetheless, before we conclude that there is only a limited difference in the use of tables and graphs by men and women, we need to consider some of the limitations of these studies. There are at least four points that should be considered:

- *Problems with journal sampling*. The number of published articles per year is not uniform across all journals. This means that some journals (and thus *JCR* categories) are more represented than others. For example the *Journal of the American Society for Information Science and Technology* has 12 issues per year and *Psychology Teaching Review* only two (not included in this study). Similarly, the number of single-authored (and single-sex articles in Study 3) is not uniform across all journals. And this is also true of the distribution of genders (i.e., although the number of males predominates there are more females in some domains than others). To overcome these problems it might be possible to standardize the contributions in some way, but we did not do this in the present study.
- *Problems in deciding what to count as a table or as a figure*. In Studies 1 and 2 the numbers of tables and figures were determined automatically according to the caption labels (e.g., Table 1; Fig. 2). However, some figures can contain a lot of text, or even (rarely) be labeled in some journals as a figure even when the data are set out in a tabular format, but these differences are not apparent from an electronic database. Nor, too, are whether or not figures contain numbers (we classified them as data tables), graphs, bar charts, maps, or even structural equations. The methods used in Study 3 can obviate this problem to some extent, but (a) they are time-consuming and (b) sometimes we found it hard to categorize a table that contained mainly text, but with one or two numbers in it. Here we classified these as data tables.
- *Problems with determining the sex of the authors*. Determining the sex of the authors from many different countries can be a difficult and error-prone task for people like us who only speak one or two languages, and where—sometimes—only the initials of the first names are given. Although *Google Scholar* proved very helpful here, in some cases (17 % in Science, 1 % in Social Sciences) we had to give up because it proved too difficult for us to find out whether an author was a man or a women.
- *Problems with different disciplinary approaches*. Finally, what might account for the differences found in Study 1? Do they simply reflect disciplinary habits? Are there generally more graphs in scientific journals than social science ones? Do more women than men write in the social sciences (and the arts) than in the sciences (Schucan Bird 2011)? And is this sex difference now declining with the increase in female researchers, see (e.g., see Kretschmer et al. 2012a, b; e.g., see van Arensbergen et al. 2012)? These articles show that the answer to most of the questions above is in the affirmative, but they also show that there is more than just disciplinary differences to account for our results.

  In this article we have equated different disciplinary approaches that might in fact in themselves make different uses of tables and graphs. Although we have distinguished between science and social science journals, we have not distinguished between the different methods used within these disciplines. Different theoretical approaches to doing research lead to different types of tables and graphs. Ashwin (2012) for instance differentiated between the use of studies in the social sciences using quantitative, qualitative and mixed methods in the USA and elsewhere. He reported that 73 % of US journals in his sample used quantitative methods, 19 % qualitative and 1 % mixed methods, whereas the percentages were 38, 39 and 12 % for non-US journals. It is likely, of course, that such different methods also use different styles of tables and graphs.

In terms of male:female distributions in different disciplines we may note Schucan Bird's (2011) finding that female academics publish proportionally less than male ones (for various reasons) in the sciences, but publish at a comparable level with men in the social sciences. In Studies 1 and 2 we found similar results, in that the male:female ratio was much higher in the sciences (4:1) than it was in the social sciences (2:1), but in our study the male:female ratio in the social sciences was double the 1:1 implied by Schucan Bird (2011).

Conclusions

Our research suggests that there are few, if any, statistically significant differences so we conclude that men and women sometimes do things differently, but most of the time there are large overlaps in their accomplishments. Study 1, in fact, was the only one that provided support for the hypothesis (H1) that men would use significantly more figures and graphs than women in the sciences. Today, the proportion of men and women entering higher education and contributing to research is increasing (van Arensbergen et al. 2012). It would indeed be interesting to try to replicate once again some of the older studies into sex differences in academic writing to see if things have changed.

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